

WHAT IS CLAIMED IS:

1. A physical quantity sensor for detecting physical quantity, the sensor comprising:

a substrate having an opening;

a beam protruding in the opening of the substrate and supported on the substrate; and

a fixed electrode supported on the substrate,

wherein the beam is movable in a vertical direction of the substrate so that the physical quantity in the vertical direction is detectable.

2. The sensor according to claim 1,

wherein the fixed electrode includes a first fixed electrode and a second fixed electrode,

wherein the first and second fixed electrodes protrude in the opening of the substrate,

wherein the beam includes a movable electrode, and

wherein the movable electrode faces both of the first and second fixed electrodes to provide first and second capacitors, respectively.

3. The sensor according to claim 2,

wherein the second fixed electrode is disposed over the first fixed electrode at a predetermined distance so that the second fixed electrode is electrically insulated from the first fixed electrode,

wherein the second fixed electrode has a top surface, which is disposed on a same plane as a top surface of the movable electrode,

and

wherein the first fixed electrode has a bottom surface, which is disposed on a same plane as a bottom surface of the movable electrode.

4. The sensor according to claim 3,

wherein the first capacitor has a first capacitance provided by a first facing area between the first fixed electrode and the movable electrode,

wherein the second capacitor has a second capacitance provided by a second facing area between the second fixed electrode and the movable electrode,

wherein the movable electrode is movable upwardly so that the first facing area is reduced in a case where the physical quantity is applied to the substrate toward an upper direction of the substrate, and

wherein the movable electrode is movable downwardly so that the second facing surface is reduced in a case where the physical quantity is applied to the substrate toward a lower direction of the substrate.

5. The sensor according to claim 4,

wherein the physical quantity applied to the substrate has a magnitude and an operation direction, both of which are detectable by measuring the first and second capacitances,

wherein the substrate is made of semiconductor, and

wherein the beam and the fixed electrode are made of doped

semiconductor.

6. The sensor according to claim 2,

wherein the movable electrode has a rod shape so that the movable electrode includes both sides and the bottom and top surfaces,

wherein both of the first and second fixed electrodes have a rod shape so that the first and second fixed electrodes include both sides and bottom and top surfaces, respectively, and

wherein one side of the movable electrode faces one side of the first fixed electrode, and the one side of the movable electrode faces one side of the second fixed electrode.

7. The sensor according to claim 6,

wherein both sides of the movable electrode and both sides of both of the first and second fixed electrodes are parallel to the vertical direction of the substrate.

8. The sensor according to claim 1,

wherein the beam is supported at both ends of the beam on the substrate, and

wherein the first and second fixed electrodes are cantilevered from the substrate.

9. The sensor according to claim 8,

wherein the beam includes a pair of spring portions, a massive portion and a plurality of movable electrodes,

wherein one of the spring portions of the beam is disposed on one end of the beam so that the one spring portion connects to the substrate to support the beam, and the other spring portion is disposed on the other end of the beam so that the other spring portion connects to the substrate to support the beam,

wherein the massive portion is disposed between the spring portions, and

wherein the movable electrodes protrude from the massive portion toward a perpendicular direction of the massive portion.

10. The sensor according to claim 9,

wherein the fixed electrode includes a first fixed electrode and a second fixed electrode,

wherein the opening of the substrate has a rectangular shape so that the substrate includes a pair of latitudinal sides and a pair of longitudinal sides,

wherein the first fixed electrode protrudes from both of the latitudinal sides of the substrate, and the second fixed electrode protrudes from both of the latitudinal sides of the substrate, and

wherein the beam, the fixed electrode and the substrate have plane symmetry.

11. The sensor according to claim 10,

wherein the first fixed electrode faces the movable electrode so that a first capacitor having a first capacitance is provided,

wherein the second fixed electrode faces the movable electrode so that a second capacitor having a second capacitance is provided,

wherein the movable electrode and the first and second fixed electrodes have a comb-teeth shape,

wherein the beam together with the movable electrodes is movable in a vertical direction of the substrate so that the physical quantity in the vertical direction is detectable.

wherein the second fixed electrode is disposed over the first fixed electrode at a predetermined distance so that the second fixed electrode is electrically insulated from the first fixed electrode,

wherein the second fixed electrode has a top surface, which is disposed on a same plane as a top surface of the movable electrode, and

wherein the first fixed electrode has a bottom surface, which is disposed on a same plane as a bottom surface of the movable electrode.

12. The sensor according to claim 11,

wherein the movable electrode has a rod shape so that the movable electrode includes both sides and the bottom and top surfaces,

wherein both of the first and second fixed electrodes have a rod shape so that the first and second fixed electrodes include both sides and bottom and top surfaces, respectively,

wherein one side of the movable electrode faces one side of the first fixed electrode, and the one side of the movable electrode faces one side of the second fixed electrode, and

wherein both sides of the movable electrode and both sides of both of the first and second fixed electrodes are parallel to

the vertical direction of the substrate.

13. The sensor according to claim 12,
wherein the physical quantity applied to the substrate has
a magnitude and an operation direction, both of which are detectable
by measuring the first and second capacitances,
wherein the substrate is made of semiconductor, and
wherein the beam and the fixed electrode are made of doped
semiconductor.

14. The sensor according to claim 1,
wherein the sensor is an acceleration sensor, a yaw-rate
sensor, an angular speed sensor or an impact sensor.